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Relationship Between The Discharge Of Sewage And Of Drainage In The Wadi Righ Channel And Groundwater On The Degradation Of Palm

S. Benguergoura Laradj *

Doctor Department of Engineering process, Faculty of Engineering,
Saad Dahlab University Blida, 9000, Algeria. samialaradj@yahoo.fr,

B. Remini **

Professor Department of Water Sciences and Environment, Faculty of Engineering,
Saad Dahlab University Blida, 9000, Algeria. reminib@yahoo.fr

Abstract
150 km long, the ancestral canal of Oued Righ evacuates water leachates into the Chott Melghir that includes 50 oases. The excess water caused by discharges of urban sewage and drainage water, combined with overexploitation and use of deep water tables caused a huge problem. The upwelling of groundwater, which led to an imbalance in the valley. Several sections of the canal are thereby polluted, in fact the water quality of the collecting canal of the valley are poor and their salt content can exceed 7 g/l of dry residue, combined with the presence of a water table near the soil surface, is one of main cause of soil sterilization of several agricultural areas, including the adjacent palm groves. To observe the alarming state of some palm groves, we paid visits during the years 2009 and 2010 in the oasis of Oued Righ. The physico-chemical analysis, have shown that the quality of these waters is degraded enough, of very high salinity (class C5), with electrical conductivity up to 26.30 ms/cm, an SAR> 28 (S4 class), a value of TDS of up to 21 g/l in the channel. Thus, canal water is mostly of very poor quality, charged with mineral salts, it is a brackish water of the sodium chloride facies, pollution is most felt in the channel upstream of station Kardeche, and decreases in the downstream at Touggourt.

Keywords: Canal-Oued Righ-Physico chemical-Palm Grove-Degradation.

1. Introduction

The oases of the Sahara are located in hyper arid areas, characterized by low rainfall**.** The palm groves are irrigated by groundwater. Since the fifties, date of discovery of the Continental Intercalary and Terminal Complex groundwater, the water endowment for irrigation has significantly increased in all oases of the northern Sahara. We are witnessing floods caused by rising water in the oases of Souf and Ouargla, and the drying up of groundwater in areas of Touat and Gourara.
If the valley of Oued Righ escaped the phenomenon of upwelling before the eighties, it was thanks to the canal (Fig.1) that crosses more than 50 oases which evacuates 5 m^3 / s of drainage and sewage water in the natural depression of Chott Melghir. Today, given the multiplication of points of sewage and drainage water discharge into the canal, several oases are experiencing upwelling waters that result in the suffocation of hundreds palm. The wastewater discharge is made in several points, anarchically, some nearby palm grove. Some of this wastewater, without pre-treatment, joins the main canal and mixes with drainage water (Fig.2).
The lack of an adequate and effective drainage system had very negative consequences both ecologically and economically; large areas with high agricultural potential, especially the palm groves of Oued Righ, are now threatened by rising water table, and degradation by asphyxiation of palm groves, (Fig.3) many groves are flooded during the winter (Tinedla palm groves, Gama'a, Ferdjaounne, El Goug...) This rise of the water table causes the accumulation of harmful salts and / or the high content of saline whitish crust on the soil surface, in fact the degree of salinity of the water table varies from 6 to 7 g/l in Oued Righ[1]..In to this framework and to better contribute to resolving of problems arising, we have set ourselves as objective the analysis of water: in different point of discharge in the collecting canal, which interconnects with the groundwater table.

Fig-1 view of salt deposits in a section of Oued Righ

Fig-2-. A point of sewage discharge in Oued Righ canal

Fig.-3-A very degraded palm grove due to the upwelling

2. Study area and equipment

2.1. Location and presentation of Oued Righ canal valley

The valley of Oued Righ is a geographical entity located on a North-South axis (Biskra-Ouargla) of about 150 km (Fig. 4). It is characterized as a low pressure zone with permanent water flow to the main drainage collector (canal) which extends in the south over a length of 136 km from the town of Goug to its natural outlet toward the chott Merouane and Meghir in the north. The canal transits an average flow of about 5 m3/s, more than 150 million m^3/ year[2].

The main activity of the valley is mainly focused on the phoéniculture. Currently the palm groves of this region represent about 25, 000 ha spread over fifty oasis, more than 2 million date palm tree of which nearly 60% of Deglet Nour[3].

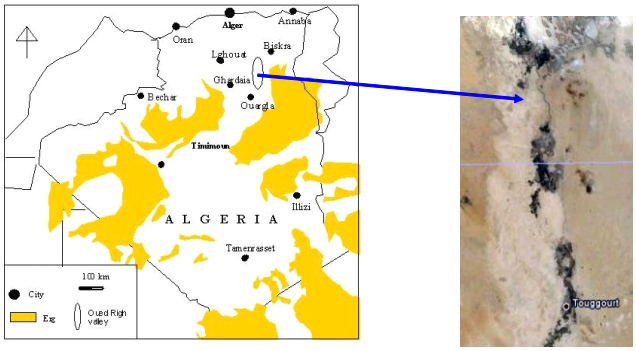


Fig-4-Location of the valley of Oued Righ

2.2. Irrigation water used in the valley of Oued Righ

2.2.1. The palm tree and drainage waters

The date palm belongs to the family of Palmae, palm originates from wet areas of all Saharan zones, The vegetation zero is located at 7 ° C, at 45 ° C. Vegetation also stops, the optimum T° is at about 32-38 ° C. The requirement for water is high in terms of date's production; some researchers estimate that it takes 1m^3 of water to make 1 kg of dates. However the most frequently used figure of 25.000m^3/ha gives a water consumption of about 4m^3 per kg of dates, for all the palm groves of Oued Righ. This amount needed for the development of 1kg of dates amounts to 6 or 4m^3. It is obvious that in different cases, a significant proportion of the water is intended for the fight against salant [4], a dose of 8 to 9 grams of salt/liter seems to be a limit not to exceed for an economically valid result. According to [Girard] in EL ARFIANNE with water containing 9 to 16 g/l of salt there's a success on the physiological level as the palm trees grow, however, the fruit are very small, 4 grams on average and their growth very long[5]. Cruesi work in Tunisia suggest the use of drainage water with (15 g/l of salt) mixed with a lightly charged water, taking ¼ of charged water and ¾ of irrigation water this mixture can then be used for irrigation[6]. The excess irrigation water supply ground water table, which is ubiquitous in all the oases of the valley of the Oued Righ, variable and generally low the depth of the water table means that the water is very salty, electrical conductivity exceeds 9 mmhos/cm in 80% of cases.

2.2.2. Types of irrigation water of Oued Righ valley palm trees

The whole valley of the Oued Righ consists of three sheets of water (figure 5):

- The first two, called «sands sheet" are artesian (gushing) their depth varies from 30m to 200m. they are highly saline (4 to 7 g/l)
- The third, called limestone sheets are located at a depth between 200 and 500 meters it is these layers that provide the majority of irrigation at present. The waters of the terminal complex (TC) become highly mineralized at the chotts Melghir and Merouane outlet 6 to 7 g/l certain (TC) areas are characterized by high salinity (C.E from 5 to 16 mmhos/cm) which is getting worse in terms of reversing the hydraulic gradient at chotts, due to the the intense exploitation

of groundwater. It is the northern area of Oued Righ. (Djemaa and Mghaier) and the southern area of Oued Righ (Ouargla) [7], the Continental intercalary (IC) is a deep aquifer (15, 000 m or more) made up of sandstone or sandy clay that extends over 600, 000 km^2 and with a thickness varying from 250 to 1000 m. This aquifer is not much used in the valley of the Oued Righ because of the cost of deep drilling, by Cartesianism provides a relatively low-mineralized water (CE of 3 to 4 mmho / cm) but whose T> 60 ° C when it flows, which poses problems of cooling prior to irrigation[3].

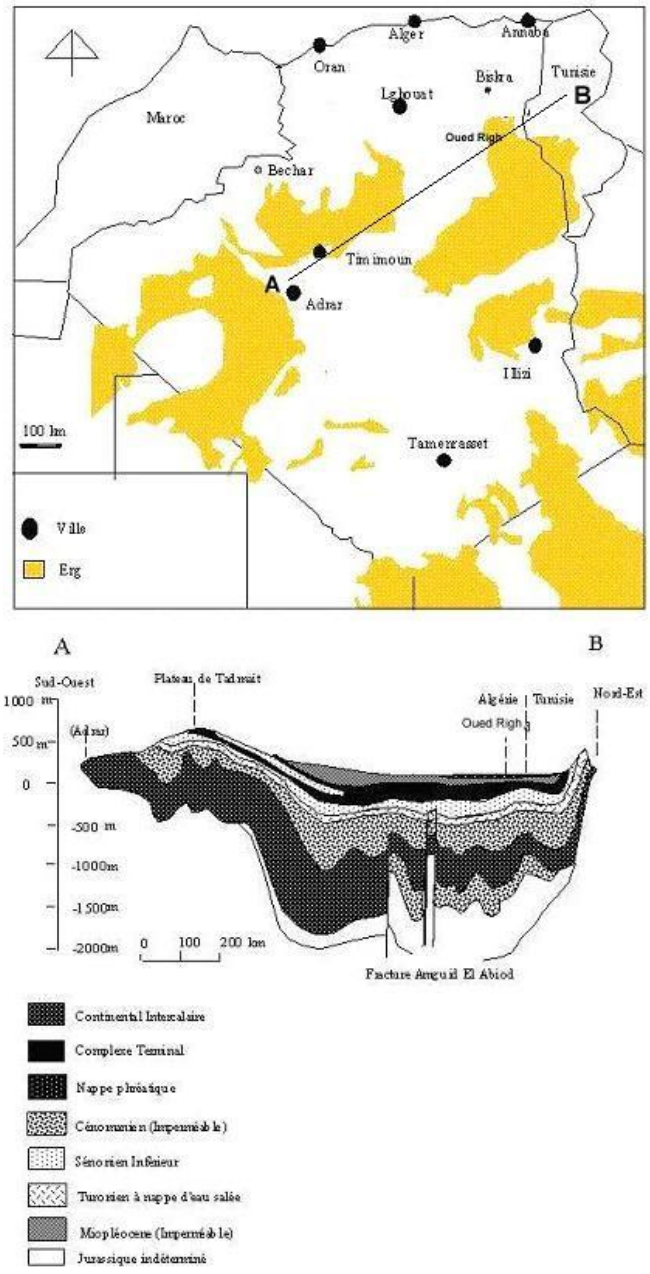


Fig-5-The groundwater of the northern Sahara

2.3. Sample Collection

The composition of wastewater is more or less variable according to the days, months and seasons given this variability, as well as transfer systems and dilution, it was difficult to perform a satisfactory sampling technique, given the difficulty of the situation of working.

In order to assess the impact of urban effluents on the canal, and subsequently its impact on date palm cultivation. Three rounds of sampling were performed over three months of the year. February 2009, and May, October 2010, and for the study of nine stations discharging into the canal, on a section of about 30 km, crossing the canal at the West (St: 1) in the East (St: 9), the distance between the station Kerdeche and the station Rannou is 19 km, and between Kerdeche and Temacine around 7 km. From the station Kerdeche to the station Zaouia El Abidia about 30 km (Fig.6).

- St: 1-Station Kerdeche upstream from the canal.
- St: 2-Station Kerdeche drainage water downstream of the canal.
- St: 3-Temacine station (canal)
- St: 4-Lake Temacine communicate with the canal.
- St: 5-Station Rannou
- St: 6-Station Aissou urban environment of Touggourt
- St: 7-Side of Step, upstream station discharge Touggourt.
- St: 8-Side of Step, downstream station discharge Touggourt.
- St: 9-Station EL Zaouia Abidia outlet Touggourt after discharge.
- We focused our research on the waters of the groundwater by means of piezometers to carry out our samples collection, our choice was based on five stations, on a section of about 46 Km, from the station to Sidi Slimane Kerdeche.
- -St: 10-Water from the water table near the cooling station
- -St: 11-Drilling C.T Aïssou
- -St: 12-Canal station Sidi Slimane.
- -St: 13-Water from the water table before the cooling station (cultivated area).
- -St: 14-Water CT Sidi Slimane irrigation water.

The samples were collected manually in plastic bottles, with identification of each point.

The choice of sampling stations for the study of spatial and temporal variation of water composition of the water table and canal water is based on finding a possible contamination of these two levels and the impact of this water on the growth of date palm tree, and the impact of the upwelling water table on the date palm cultivation. In this study we try to give some solutions to these problems.

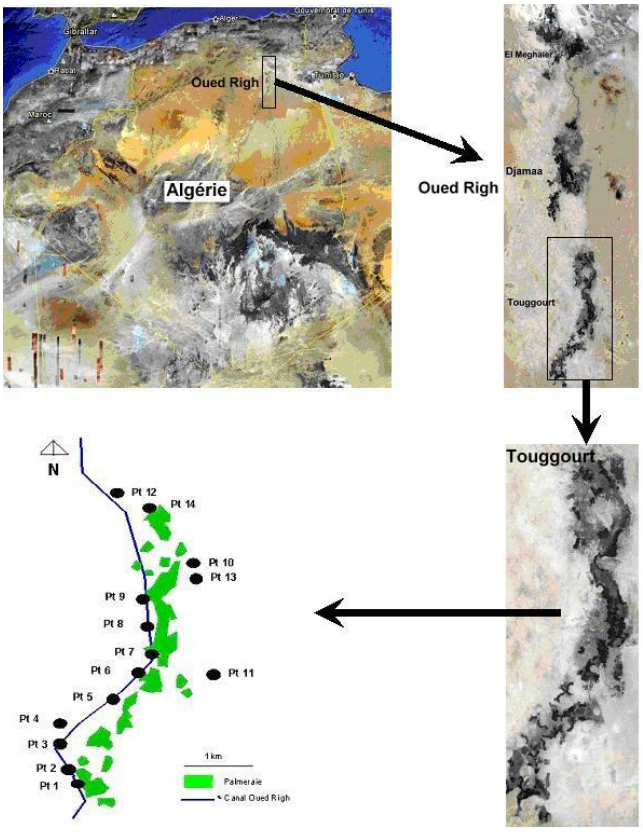


Fig-6-Location of the Oued Righ canal and the different sampling points

2.4. Used Equipment

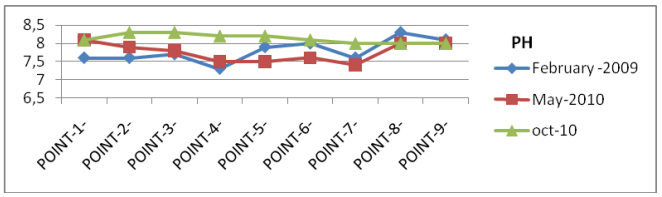
We performed the water samples physico-chemical and pollution analyzes in water treatment laboratory of National Agency of Hydraulic Resource (NAHR). Measurement procedures are deducted from the standard analytical methods. The pH is determined using a pH meter (WTW), the conductivity is determined using an electrical conductivity meter (DELTA OHM) which gives directly the sample conductivity in mmhos/cm, or in ds/m. The total and calcium hardness are determined by complexometric, by titration with (EDTA). The chlorides are determined by the Mohr method. Sodium and potassium were determined by flame emission photometry. BOD5 with a BOD meter. COD by acid digestion (sulfuric acid). Finally a variety of analytical methods had to be used for the various experimental tests, going through titrimetric methods, electrochemical and spectroscopic methods.

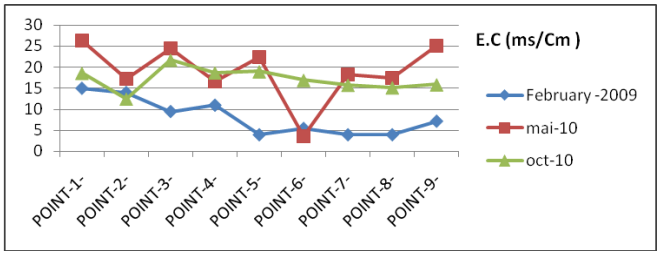
3. Results and Discussion

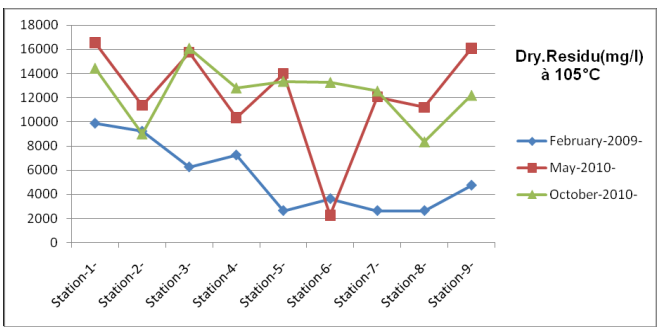
3.1. Study of physico-chemical and pollution parameters in the waters of Oued Righ canal.

Canal waters are subject to seasonal variations, the results show an evolution over time of the physicochemical properties and pollution of the canal. The concept of temperature is very important and must be taken into account when attempting to perform analyzes, in this study it is generally varying from 12 ° C in winter to 38 ° C in summer, an average annual of 22.5 ° C.

- The PH of the canal water shown in (Fig.7) ranges from 7.3 to 8.3, most canal waters are of bicarbonate alkalinity especially in (summer).
- The conductivity illustrated in (Fig.7) shows that all measured values indicate a very high mineralization, we see that this conductivity varies from 1.50 to 26. 30 ms /cm, it is nevertheless very high in the months (May and October) level of St1 and St 9. The lowest values were recorded during flood (February), this is due to the large dilution that the channel knows in this period. It should be noted that at conductivity >20 ds/m, only the palm can vegetate normally beyond 22.5 ds/m waters are strictly unusable, it allows us to classify our waters in class C5, exceptional water [7].
- The dry residue is a source of pollution, in this study it indicates values ranging from 2.64 to 16.528 g/l, these values are higher in summer at St1 and St 9, this is due to water evaporation, and we note values lower at St 2, St 6 and St 8 (Fig. 7)
- The TH-(total hardness), measures the water hardness, values TH range from 73 °F to 368 °F (in February), its content increases from 344° F to 582 ° F (in October), this month is considered hot in this region, the hardness is considerable in St 1 and St 2, and it is less important in St 6 St 7 during floods and that as a result of dilution of the canal water, these results are illustrated in (Fig.7).
- TAC (total alkali) varies from 17 °F in the St 6 to 34° F in St.1, TH and TAC confirms the high hardness of the water channel shown in (Fig.7).







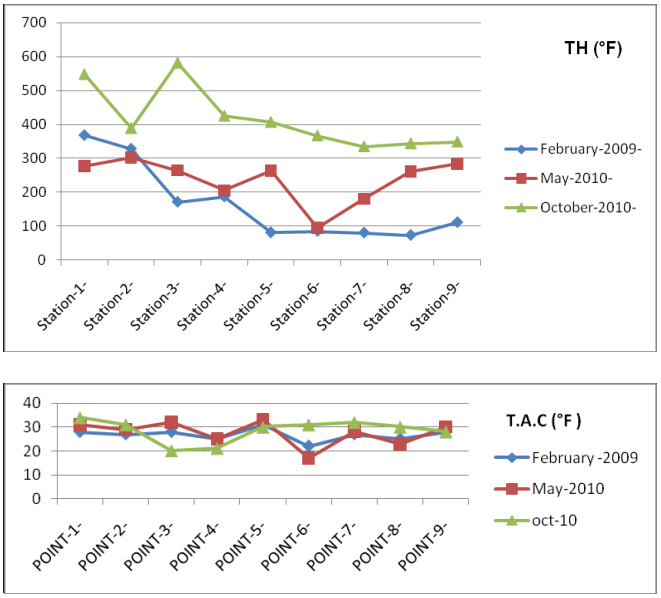
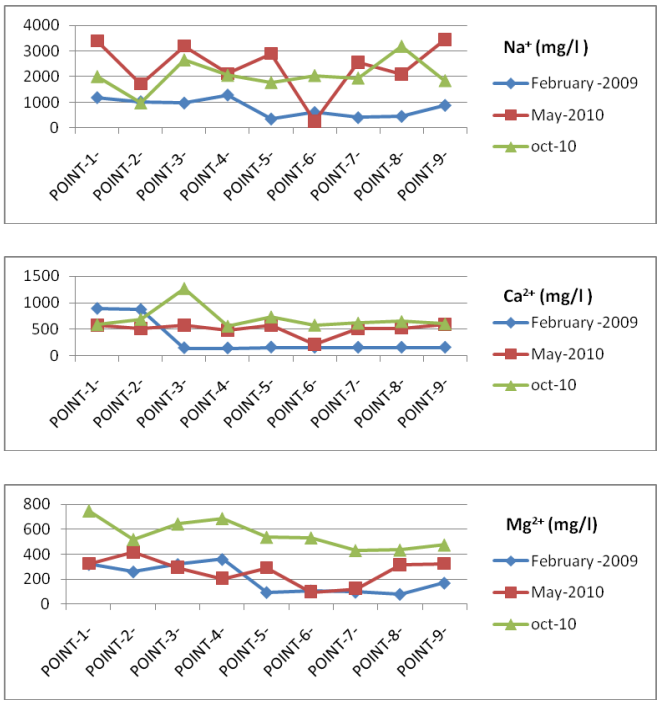


Fig-7-Spatiotemporal evolution pollution waters and physico-chemical balance of Oued Righ canal

3.2. Study of the spatio-temporal variation of the salinity parameters

- The salinity of the waters of the canal is very high, hence the sodium (Na) content which is very significant and directly contributes to the total salinity of the waters canal (Fig. 8), this element source of the alteration of rock and soil, thus there's a breakdown of aggregates that gives waterproof hard and compact soil. The critical rate of Na not to exceed the total cations in water is 50%, if the soil is chalky, or does not exceed 67% without making of corrective action[8], it was recognized that its concentration in water has harmful effects on soil structure. The increase of Na in the water makes absorption of mineral elements by the plant more difficult, which gives palms with root and leaf burns, it is therefore possible that the accumulation of Na is associated with a reduction in the accumulation of other cations as to create an unfavorable cationic balance (antagonistic effect) [9].
- Calcium (Ca) and magnesium (Mg) are recognized to be toxic when they accumulate in high concentrations in saline solutions soil, However, this toxicity varies with the presence of other cations or anions (antagonistic effect), the values of Ca and Mg are shown in (Fig.8).
- Chlorides in the water originate mainly from the dissolution of sedimentary rocks and that cause little environmental damage. The rate of chloride in the canal is very high, give a toxic effect and causes a sharp reduction in plant growth resulted in burning of leaves, scorched cementum or tissue necrosis of leaf tips, or even the complete leaf leading to the fall of this latter (Fig. 9). Root growth can be slowed; it is even possible to slightly reduce production and fruit size[10].
- Sulfates may be subject to the inhibitory effect on growth by impairing cation balance of the plant. We note high values (Fig. 9).
- The bicarbonates, this element is very important at St 1, St 5 (Fig. 9) in the month (May), the deposit of bicarbonates produce few symptoms of chlorosis by acting on the mineral nutrition of the tree.
- The composition of chemical elements in the canal follows the following order:

($Na^+ > Ca^{2+} > Mg^{2+} > K^+$) and ($Cl^- > SO_4^{2-} > HCO_3^{2-}$) in (February) and almost at all stations. However the order ($Na^+ > Mg^{2+} > Ca^{2+} > K^+$) and ($SO_4^{2-} > Cl^- > HCO_3^{2-}$) concerns the sampling points of St 3, St 4 and St 9. For the month (May) the order is the same for all sampling stations, ($Na^+ > Ca^{2+} > Mg^{2+} > K^+$) and ($Cl^- > SO_4^{2-} > HCO_3^{2-}$**).**
During (October) this order changes at St 1 and St 4 and becomes ($Na^+ > Mg^{2+} > Ca^{2+} > K^+$).
But at all stations we have ($Cl^- > SO_4^{2-} > HCO_3^{2-}$). In conclusion the majority of the canal water are concentrated in Na^+ and Cl^-, SO_4^{2-}ions are higher than Ca^{2+}, the majority of waters are relatively much more concentrated in Cl^-than in SO_4^{2-}, it means that some chemical properties of the canal water derive their character of soil properties, which is 40% gypsum texture[11]. All these gypsum accumulations represent a major constraint on both the physical and chemical aspect for better land management and sustainable agriculture and productive[12]. The presence of gypsum in all soils is the result of the composition of the parent material and its distribution in the soil profile is due to movement caused by the action of the active shallow aquifer, of which the roof does not exceed an average of 1 m in all palm groves. The combined action of a climate characterized by an intense evapotranspiration and the presence of a shallow water table that most soils undergo the phenomenon of secondary salinity, salinity type is of calcium sulfate or magnesium on average, and sodium chloride in general (Fig.10).



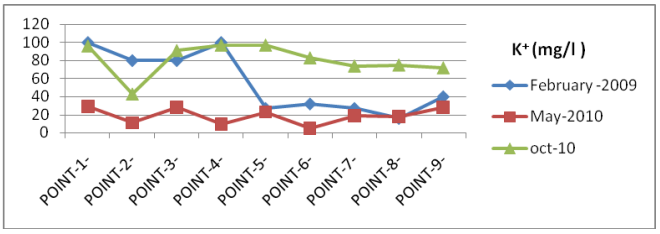


Fig-8-Spatiotemporal evolution of the cations in the waters of Oued Righ canal

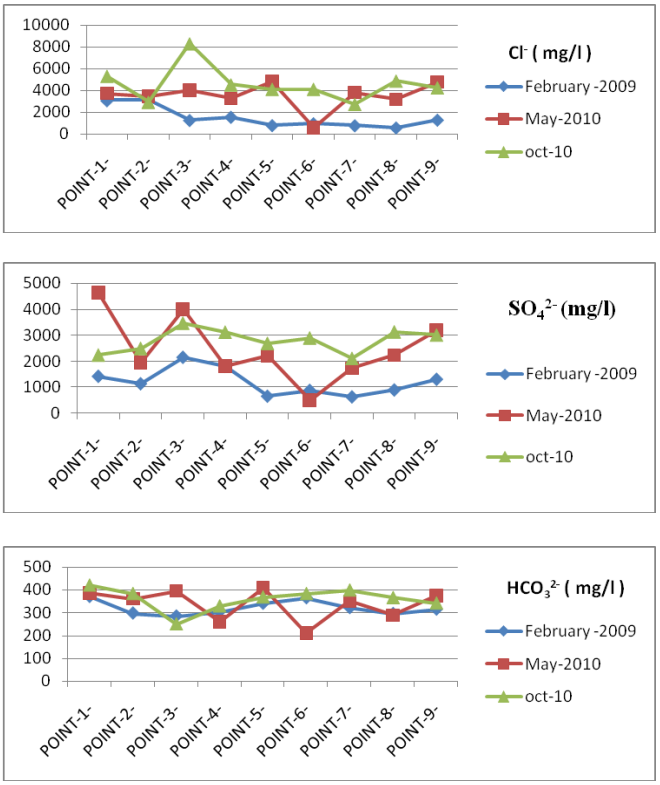


Fig-9-Spatiotemporal evolution of anions in the waters of Oued Righ canal

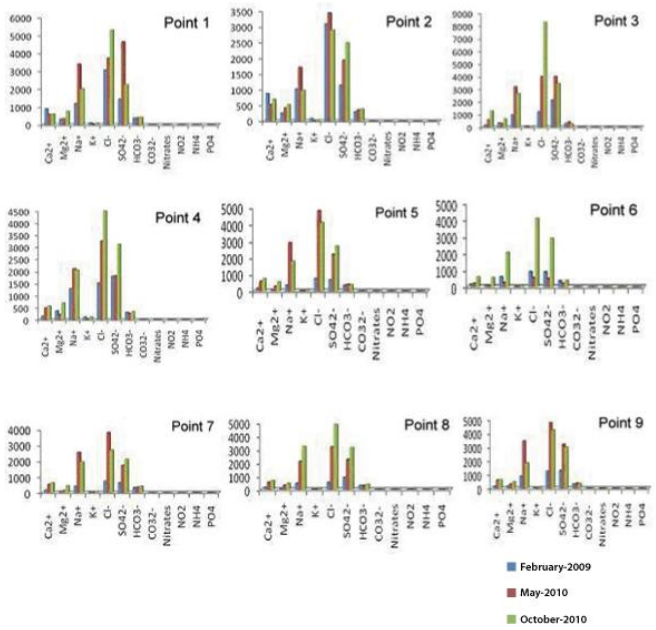


Fig-10-Evolution of chemical parameters of the canal waters of Oued Righ valley [13].

3.3. Water quality of the groudwater table

The waters of the phreatic water table have high rates of Na mainly in St 12, but in the overall the values of Na in the water table are much lower than the values in the canal.

Ca and Mg salt concentrations are shown in (Fig.11), as well as chlorides, sulfates and bicarbonates are all very high at St 12 (Fig.12), they follow the order of ($Na^+ > Ca^{2+} > Mg^{2+} > K^+$) and ($Cl^- > SO_4^{2-} > HCO_3^{2-}$), all the anions of St 10, ST 11, ST 13 and ST 14 follow the order ($SO_4^{2-} > Cl^- > HCO_3^{2-}$). (October 2010).

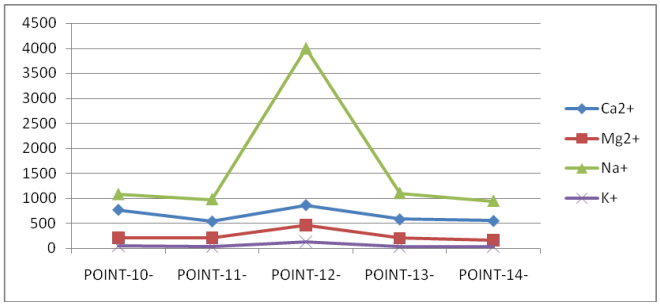


Fig-11-water cations spatiotemporal evolution of Oued Righ region water table

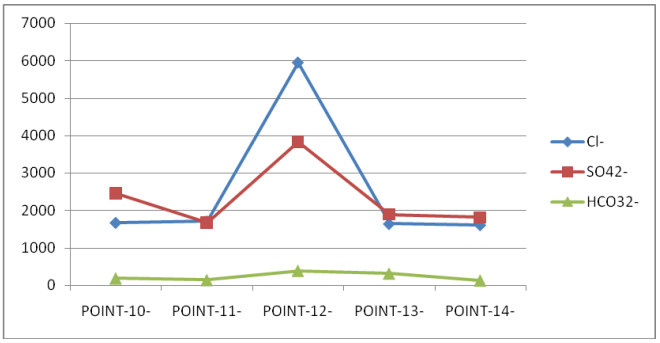


Fig-12-Evolution of spatiotemporal water anions of Oued Righ region water table

The values of pH, EC, and Dry. Residu always present a maximum at the St 12 (Fig. 13). These samples were carried out in (October 2010).

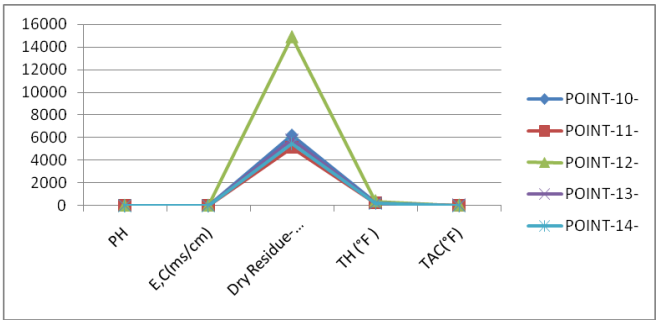


Fig-13-spatiotemporal evolution of waters pollution and physico-chemical balance of Oued Righ region water table

3.4. Water-Soil Relationship

- The waters of the canal present a very high risk of alkalinisation, with a sodium adsorption ratio (SAR) ranging from (3.55-28.30 meq/l) (Fig.14), the highest values are (in May). But the limits for a strongly sodic water are between 26 <SAR <100, thus we can classify our water in class S4, strongly sodic water[7].
- The calculation of the SAR of water leads to the possible estimation of the ESP (exchangeable sodium percentage) of soil towards which it evaluates, and also results in comparison with the% Na found, these results are illustrated in (Fig. 14), we can see that the values of the ESP range between 5.31 < ESP % < 70.6, and that of the found Na % vary between 44.17 < % Na < 79 with maximum values at the month (may).
- The TDS (total dissolved salts) shown in (Fig.14) have very high values reaching on average up to 21 g/l which reflects a high accumulation of salt that can affect the growth of palm trees. Indeed all plants irrigated with water at 5000 ppm die and only a few survived the concentration of 2500 ppm [14], in this study these values sometimes exceed these standards, hence the decline of palms.
- OP (osmotic pressure), the high salt content increases the OP in the soil solution, which leads to the concomitant decrease in the water available for the palm trees, an important physiological characteristic of halophytes is that cellular fluids OP tend to reach relatively high values[15]. In our work the values of OP shown in(Fig-14)-are relatively high at St 1 and St 5, St 9 (May) coming up to 9.47 atm, values that reflect a net decrease in the growth of palm trees in these areas.

The salts of the soil and salty water can act in two ways on the germination of the palm.

- There may be enough salt in the environment where the shrub is, to increase the OP of the soil solution so as to delay or prevent absorption of needed water. Because the more there's salt in the water less the water can get into the plant.
- Some salts or ions therein may be toxic to the embryo of the palm.

The date palm is among the most tolerant plants to salts[16], reported a growth of date palms in the Coachella Valley in California, where the soil solution with a moisture content is close the wilting percentage contained 15000ppm of salt, an osmotic concentration of 7 atm.

The calculation of the parameters that connects the water to the soil as (SAR, TDS, OP and % Na found) are very high at the St 12 (Fig.15). Waters of the groundwater are contaminated with water pollution of the canal, and that there's a very direct relationship between the canal and the water table, Whence withering palm groves in the St-12-Station Sidi Slimane.

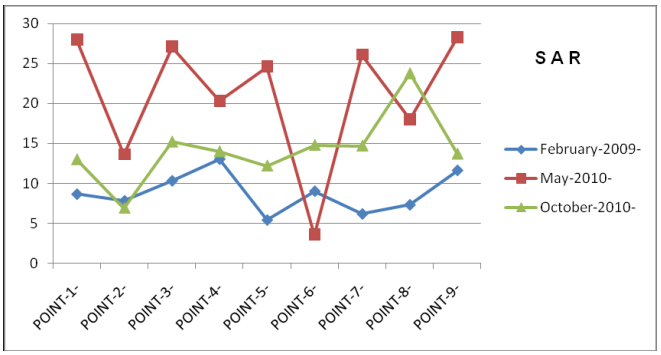
4. Metal analysis

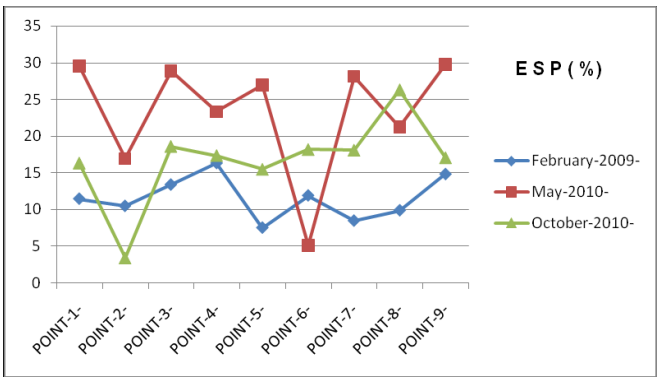
To eliminate any possibility of another kind of contamination, metal analysis was performed on the canal (table 1), it does not reflect major abnormalities except a trace element in some stations, this may explain the fact that the canal is far from being near an industry and its waters are practically of domestic origin (urban), and drainage.

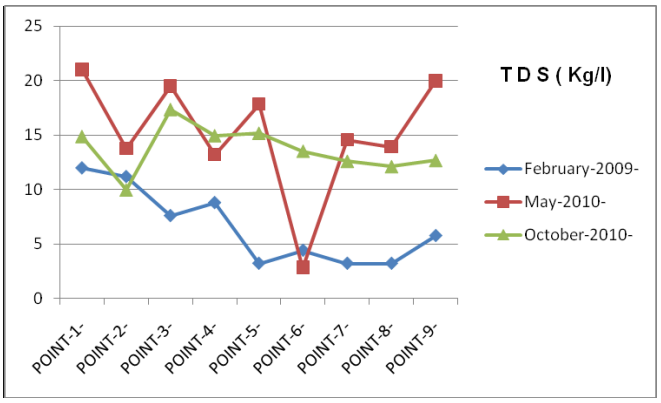
Table 1. Metal analysis in the Oued Righ canal

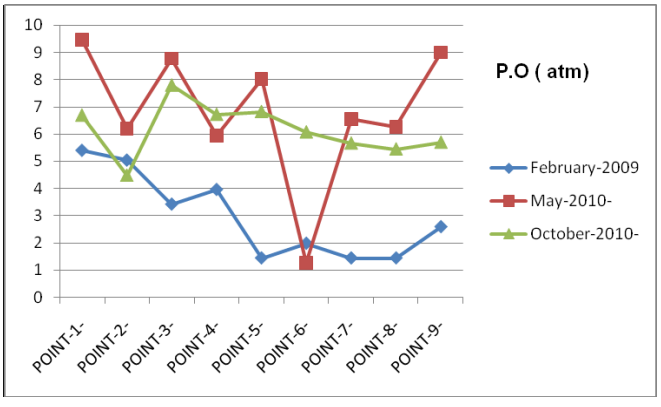
	Iron	Manganese (mg/l)	Lead (mg/l)	Copper (mg/l)	Zinc (mg/l)	Total Chromium (mg/l)	Cadmium (mg/l)
1	< 0, 002	0, 0250	< 0, 01	< 0, 0004	0, 035	< 0, 002	< 0, 001
2	< 0, 002	< 0, 0004	< 0, 01	< 0, 0004	0, 028	< 0, 002	< 0, 001
3	< 0, 002	<0, 0004	< 0, 01	< 0, 0004	0, 026	< 0, 002	< 0, 001
4	0, 054	0, 0290	< 0, 01	< 0, 0004	0, 025	< 0, 002	< 0, 001
5	< 0, 002	0, 0180	< 0, 01	< 0, 0004	0, 025	< 0, 002	< 0, 001
6	0, 006	0, 0220	< 0, 01	< 0, 0004	0, 024	< 0, 002	< 0, 001

7	0, 002	0, 0260	< 0, 01	< 0, 0004	0, 023	< 0, 002	< 0, 001
8	0, 009	0, 0270	< 0, 01	< 0, 0004	0, 023	< 0, 002	< 0, 001
9	0, 025	0, 0210	< 0, 01	< 0, 0004	0, 022	< 0, 002	< 0, 001









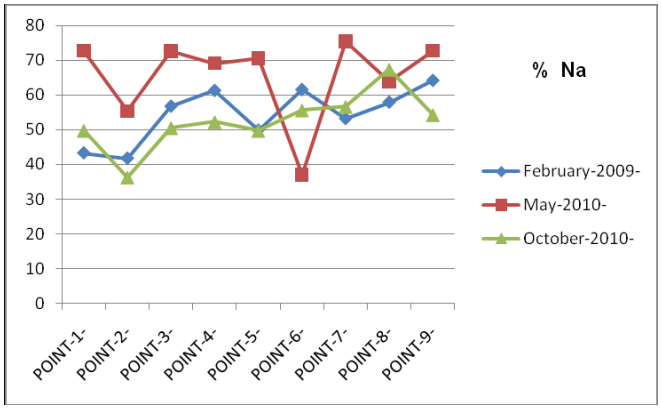


Fig-14-spatio-temporal evolution of different parameters connecting to the soil and water of Oued Righ canal Waters

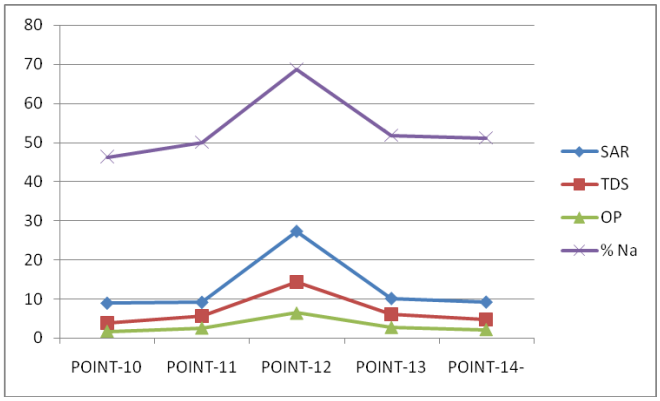


Fig-15-spatio-temporal evolution of different parameters connecting to the soil and water of groudwater

Conclusion

In order to determine the effect of discharges into the canal, and their impact on the palm tree heritage, a study of some physico-chemical parameters was carried out. The results show that the canal water quality is quite degraded, the impact of pollution is more felt at the St 1: Kerdeche station upstream of the canal, and the St 5: Rannou station. The St 6: Aissou station located in urban Touggourt also presents a rather degraded aspect, this degradation decreases slightly at the St 8: downstream of the step (Sewer) Touggourt discharge, to increase and intensify at the St 9 Zaoui El Arbidia station located at the exit of Touggourt after the discharge.

- The amount of salts presents in the canal and the contamination of the groundwater and consequently of palm groves remains a problem we should try to minimize. The type of salinity is calcium sulfate or magnesium on average, and sodium chloride in general. In fact the date palm is one of the most tolerant grown plant to salt 9-16 g/l (Coachella Valley in California) and (El ARFIANE palm in Algeria) where the soil solution has a moisture content close to the wilting percentage contained 15000ppm of salt, an osmotic concentration of 7 atm. Values somewhat lower than the values obtained in

our study, reflecting the obtaining of small fruit with very slow growth, and even in some places palms fading.

- The waters of the water table are characterized by a less important pollution except at one point St 12: Sidi Slimane station is a cultivated station located not far from the collecting channel, which explains the contamination of the water table by the water of the canal. The chemical properties of the canal water derive their character of soil properties, which are 40% of gypseous texture, which represents a major constraint for sustainable and productive agriculture. The combined action of a climate characterized by an intense evapotranspiration, and the presence of a shallow water table causes that most soils are subject to the phenomenon of secondary salinization.

The fight against the degradation should prevent mechanisms according to the availability of these elements towards other soil components. In fact, assessing the degree of contamination of discharges should into account what actually comes out of discharges, the availability of these elements in comparison with other soil components. It would therefore be necessary to determine the mineralogical characteristics of sediments studied and the percentage of ion exchange clay. Especially to find:

- A means of pretreatment of water before discharging in the canal. Installing a treatment plant with an aerated lagoon where adjacent locations wastewater undergoes treatment before being returned to the main collecting canal.
- Increase the frequency of irrigation, increase water supply to plants by considering the needs of leaching and / or association of different water sources.
- Controlling the exploitation of deep groundwater, to prevent the underground water upwelling, and the flooding of agricultural land
- Finally raise public awareness to save water

References

[1] M.S, Adriani, " Research on community ecology of some associations" halophilic Mediterranean. Proceeding of International Seminar geobotanical Mediterranean and Alpine, Montpellier, communication, n° 32, pp 9-31, 1934.

[2] E, Braudeau, M, Hachicha, " Irrigation project in the lower valley of the Medjerda and Ras Jebel. Guide for monitoring water salinity and soil", Bulletin of the management of soils Tunisia. 247 p. 1998.

[3] S, Benguergoura Laradj, B, Remini, "The Releases of wastewater in the oued Righ valley : the palm groves in declining", Desalinisation and water treatment Journal, V.52, London, UK, pp 2187-2192, 2013

[4] Cruesi, " Research and training on irrigation with saline water", Technical Report 1962-1969, Unesco, 1970

[5] I, Cserni I, " Analysis of soil hydraulic conductivity in palm plantation in the saline soils of the Oued Righ", 2002.

[6] M, Girard, "News in the field of research of phoeniculture", Days of the date, Algiers 3-4 May. 1961.

[7] HE, Hayward, "Program of the arid zone-Plant growth in saline Reverside", California United States, May, UNESCO / N / AZ / 81, Paris**.**1952**.**

[8] CH, Killian, Faubel, "Observation on the osmotic pressure of plants and sub-arid Algeria's" Botanical Society of France, Volume 80, N° 9-10.Paris, pp 175-178, 1933.

[9] H, Klintworth, " The use of water for irrigation Brack", Farming in 360 south africa. Vol 27, No. 311 Pretoria, February, pp 45-51, 1952.

[10] A, Khadraoui, " Soils and agricultural water in the Algerian oasis, characterization, constraints and development proposals", Publishing at the author, 317p, 2005.

[11] A, Khadraoui, " Water and environmental impact in the Algerian Sahara. Definition-Evaluation and development prospects. Publishing at the author, 305 p, 2005.

[12] AM, Mashali, " Soil mangement practices for gypsiferous soils-international symposium on soils with gypsum",-léida, Espagne, pp.34-52, 1996.

[13] EI, Ratner, " The influence of exchangeable sodium in the soil on its properties as a medium For plant growth" soil, sci, vol 40, pp 459-471, 1935.

[14] OC, Magistrad, RF, Reitemeir, " Soil solution concentrations at the wilting point and their correlation with plant growth" soil sci, vol 55, pp 351-360, 1943.

[15] P, Simonneau, " Observation on irrigation of date palm", The days of the date, Algiers 3 to 4 May 1961, 1961

[16] Unesco (1957). Use of saline waters. Proceedings of Research on arid, NS.56 III, 5 F.